Miscellaneous
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SOIL AND WATER CONSERVATION RESEARCH IN THE GREAT PLAINS STATES

AGRICULTURAL RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

THE CONSERVATION TEAM . . . .

Soil and water are the Nation's two most vital natural resources. The orderly development and the conservation of these resources depend on the efforts and interests of many groups. Collectively, they are called the Soil and Water Conservation Team. This team includes farmers, ranchers, Soil Conservation District personnel, technicians, teachers, extension workers, economists, and research workers.

THE ROLE OF RESEARCH . . . .

An effective soil and water conservation program must be based on sound technical information. Research has provided this pool of knowledge. Practices now being applied reflect the results gleaned from many years' experience.

But we need to know more. Our expanding population and the consequent demands for more food and fiber have created new problems in the management and use of soil and water. Facts gained from today's research will provide the bases for conserving tomorrow's soil and water.

THIS PUBLICATION describes a few examples of recent soil and water conservation research. Scientists and engineers of the Soil and Water Conservation Research Division, Agricultural Research Service, have cooperated with the personnel of the State agricultural experiment stations in developing the research that is in progress.

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Growth Through Agricultural Progress

Prepared by the

Soil and Water Conservation Research Division

AGRICULTURAL RESEARCH SERVICE

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SOIL AND WATER CONSERVATION RESEARCH

in the Great Plains States

Conservation, efficient use, and management of available moisture supplies for plant growth on cropland and grassland are major problems in the Great Plains. In much of the southern Plains, moisture conservation and soil blowing as a result of limited rainfall are closely related. In the eastern half of the Great Plains, water erosion continues to be one of the very difficult conservation problems.

Irrigation has increased rapidly in the Plains since 1940. Irrigation water management practices have a major effect on water erosion; in a poorly designed irrigation system, the water application can cause serious erosion to fields.

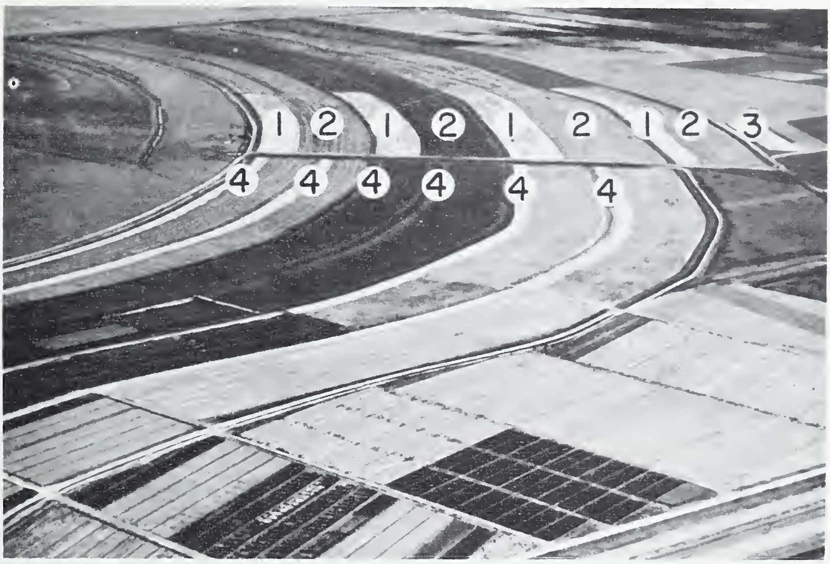
The solution of soil and water conservation problems requires an intensive field experimental and investigational program supported by adequate laboratory and greenhouse research. From this research, practices are developed that can be applied to the land to conserve our resources.

LEVEL BENCHES DISTRIBUTE WATER UNIFORMLY

BN-15324

A series of conservation level benches provide uniformity of distribution of water. Water has accumulated from contributing areas adjacent to the benches.

BENCH LEVELING ON DRY CROPLAND



BN-15322

Forming land to hold water where it falls and concentrating and spreading the water holds great promise in the Great Plains.

After a runoff-producing storm of 6.25 inches of rain in 1 week, the photographs show (1) water held on level conservation benches spread in a thin sheet, with clods and residue showing through the water; (2) areas above the conservation benches from which runoff occurred during the high-intensity storm; (3) level bench that received no water from contributing areas; (4) level, closed-end terraces where water held above the level of terraces is concentrated in narrow, deep channels.

SORGHUM STRIPS TRAP SNOW

BN-15320

Drifting snow that is normally blown off large wheatfields can be effectively deposited and spread onto wheat by means of double rows (14 inches apart) of sorghum stubble, which act as parallel snow fences spaced 40 to 80 feet apart.

In this area, an additional 2 inches of soil moisture was obtained by holding most of the 32 inches of snow in place in the winter of 1959-60.

SURFACE RESIDUES PREVENT WIND AND WATER EROSION

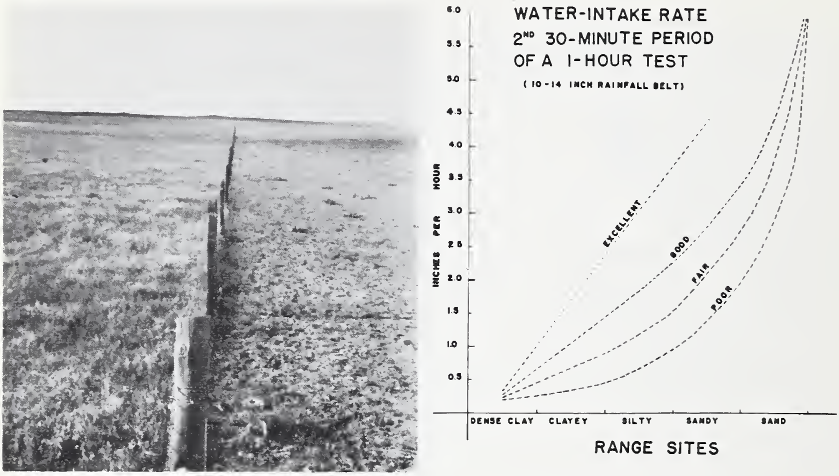
BN-15321

With limited rainfall in much of the southern Great Plains, the dual problems of moisture conservation and soil blowing are closely related. To improve conservation farming under these conditions, surface residues are often used to control soil blowing.

In the experimental plots shown above, methods of sorghum residue preservation for soil and water conservation are being developed on sandy soils for cotton production. Wider-than-normal cotton rows and sorghum residue left on the soil surface protect the soil against wind and water erosion.

Row systems and sorghum residue management are being studied in a 2-year cotton-sorghum cropping system. A cotton plot with rows 80 inches apart has considerable sorghum residue still available from the crop grown the previous year in 20-inch rows.

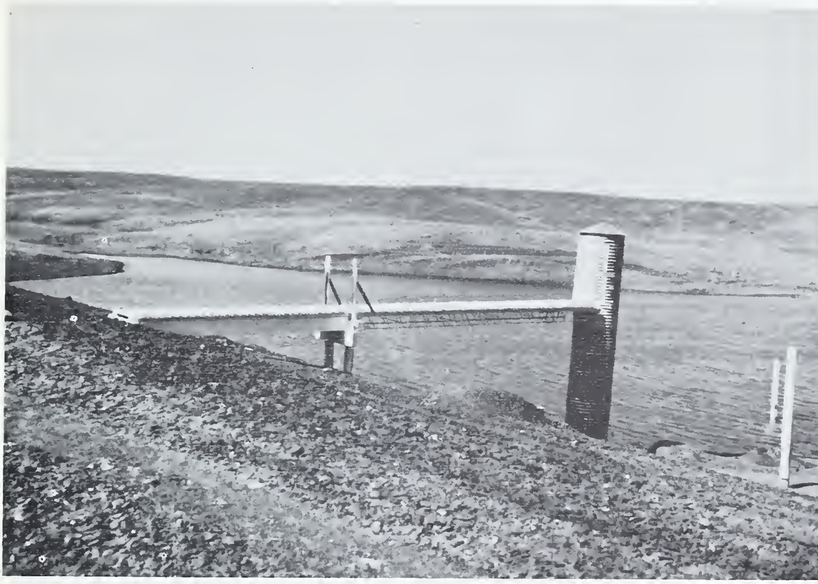
GOOD GRASS COVER CONSERVES MOISTURE



BN-15323

Maintenance of dependable feed supplies on grasslands is a necessity for ranchers. Research and experience have shown that good grass cover conserves moisture and controls erosion. Water intake rate is two to three times higher (left) on grassland with good cover than that with poor cover (right). Improved water intake means less runoff, more grass, less erosion, and, as a result, bigger gains for cattle than on poor grassland cover.

The chart shows that the range condition is the dominant factor that governs water-intake rate, particularly on the medium- and fine-textured soils.



BN-15302

Watershed research on rangeland provides information on (1) precipitation-runoff relations under different land and climatic conditions; (2) effect of land treatment on runoff and sedimentation; (3) effect of prolonged channel flow from water-flow detention structures on streambank stability; and (4) accrued benefits from a watershed protection and management program on small watersheds.

This photograph shows a 90-acre experimental watershed with the dam in the foreground. Standing water is measured by a water-stage recorder inside the stilling well. Water stage is observed at weekly intervals on the staff gage attached to the right of the well. One storm usually provides the major water yield from watersheds similar to the one shown above.

INUNDATION TOLERANCE OF GRASSES AND LEGUMES TESTED IN FLOOD POOL AREAS

BN-15303

As the construction phase of the upstream flood-control program continues to expand, more and more agricultural land--primarily grassland--is subjected to periodic flooding behind dams. In these flood pool areas, too little is known about inundation tolerance of the various grasses and legumes. It is necessary to determine the best adapted species for this purpose, so that the land may be productive and at the same time provide grass cover for control of soil erosion and sedimentation.

The view above is one of six water-impoundment structures where 18 grass varieties were planted in 2-foot wide rows that parallel the natural slope (7 percent). These structures are to be filled with water to determine the flooding tolerance of each grass at different seasons, at different flood depths, and for different lengths of time.

WATER YIELD AND FLOOD FLOWS MEASURED FROM SMALL WATERSHEDS

BN-15304

Estimates of how much water is available are needed to plan for size of stock ponds, amount to use for water spreading, and related uses. Also, peak flood flows from small watersheds must be estimated if road culverts, check dams, pond spillways, and terrace outlets and waterways are to be properly designed.

The flume above is used to measure runoff and flood peaks from a small single-crop, single-treatment watershed. The small building and bridge in the background mark the location of a weir to measure runoff and flood peaks on a 480-acre mixed land-use treatment watershed.

BN-15305

BN-15306

WATER MANAGEMENT AND FERTILITY IMPORTANT IN MOUNTAIN MEADOWS

Poor irrigation water management and low available nitrogen--as indicated by the top photograph, opposite page--resulted in approximately 1 ton of low-quality forage per acre. Water is standing on the surface, runoff is uncontrolled, grass density is low, and weeds are predominant in this meadow.

Improvement of the production of these meadows requires at least four steps:

1. Changing the irrigation system from wild flooding to controlled irrigation.
2. Changing the crop from low-producing, water-loving plants to high-producing, more efficient water-using plants.
3. Supplying nitrogen through either a commercial fertilizer or by growing legumes in association with the grass.
4. Controlling grazing to assure good livestock response to the forage.

The bottom photograph shows good grass cover with few weeds, which was brought about by controlled irrigation and efficient water management. In this experimental area, two rates of commercial nitrogen--50 pounds N (left) and 100 pounds N (right) per acre--were applied. The heavier application of nitrogen provided the more vigorous growth and darker color for the grass-legume mixture.

LEVEL IRRIGATION SYSTEMS PROMOTE EFFICIENT USE OF WATER

BN-15307

Level border irrigation systems provide (1) higher application and distribution efficiencies, (2) more uniform water distribution, (3) reduced labor costs, (4) elimination of runoff from rainfall or irrigation, (5) control of salinity by leaching, and (6) reduction of excess water used that contributes to drainage problems.

In the field above, water-intake measurements are being recorded during irrigation. The effect of different soil management practices on water intake is also being studied.

BORDER CHECK IRRIGATION SYSTEMS ARE EFFECTIVE ON SLOPES

BN-15308

Two views of a border check irrigation system, which has level or low-gradient slope benches with border checks and closed ends. This irrigation system is on sloping land of 2 to 5 percent. Excessive erosion that occurs on downslope irrigation systems is controlled by the nearly level bench irrigation system. Also, more uniform distribution of water is possible, and its application is 80 to 85 percent efficient. All rainfall is held where it falls with the border check system, thus extending and conserving available irrigation water supplies.

SALT ACCUMULATIONS A PROBLEM ON DRYLANDS

BN-15309

Some areas in the grain sorghum field shown above are barren. Soils in the barren spots are too high in salt for seedling germination and crop growth. The salt accumulations are caused by a high water table and deposition of salts on the soil surface when the soil moisture evaporates. Evaporation rates are higher on the barren soil because of high soil temperatures.

In the foreground are small evaporation control plots, where the effect of various soil covers on soil temperatures is being measured to obtain data for the planning of a suitable management system.

SALT PROBLEMS STUDIED ON IRRIGATED LANDS

BN-15310

Associated with irrigation, salts often accumulate at the surface of many Plains soils, as is evident by the white crust in the photograph above. These salts will increase beyond the tolerance level for plants unless proper irrigation and drainage practices are used. Vegetative growth is restricted or crops do not grow in the salt-affected areas. Research is underway to find ways and means of preventing the development of salted areas, as well as to find new techniques for reclamation.

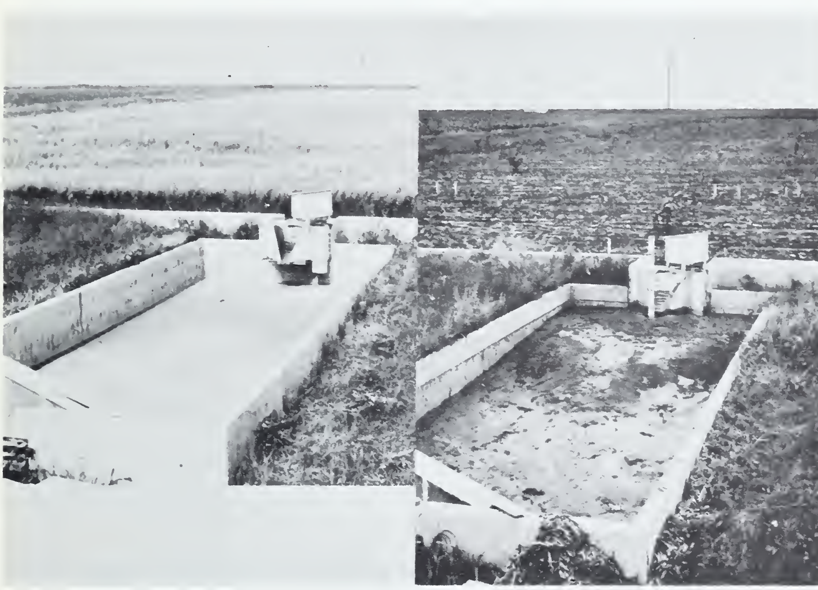
IRRIGATION SYSTEMS AND CROP MANAGEMENT STUDIED FOR EROSION CONTROL

BN-15311

High soil loss and severe erosion damage occur when intense storms follow soon after irrigation water has been applied and the soil profile is filled near field capacity.

In the experiment above, runoff and erosion losses are being measured in a field where sprinklers are used to simulate rainfall. In this study, efforts are being made to determine the proper grade and the effective soil management practices that will allow orderly disposal of excess water with a minimum loss of eroded soil.

CLOSE-GROWING CROPS PROTECT LAND DURING HEAVY RAINFALL



BN-15312

Water erosion is particularly severe in the eastern half of the Great Plains. During the heavy rainfall season, close-growing crops offer excellent land protection, as contrasted to soil and water runoff on continuous row crops of cotton and corn.

The silt boxes above show that only a trace of soil loss occurred (left) from the oats-sweetclover plot after a 7.7-inch rain over a 4-day period, whereas the loss (right) from the row crop amounted to 7.9 tons per acre. Only 0.1 inch of runoff occurred from the close-growing crop, as compared to 3.3 inches of water from the row-crop system.

PARALLEL TERRACES ACCOMMODATE LARGE MECHANICAL FARM EQUIPMENT

BN-15313

Terracing has long been accepted as a basic conservation measure. Much effort has gone into the development of different types of terraces for specific purposes and ease of management.

With the advent of farm mechanization and the use of 4- and 6-row equipment, terrace design had to be changed in order to avoid point rows and sharp angles on terrace ridges. Parallel terraces, as shown above, offer considerable promise for continued use of terraces, yet these terraces permit efficient use of large tillage, cultivation, and harvesting equipment.

SYSTEMS FOR STUBBLE MULCHING ARE BEING STUDIED

BN-15314

A contrast in types of tillage: At left, adequate quantities of vegetative cover have been retained on the surface of the soil to provide protection against wind and water erosion; on the right, the residue has been incorporated in the soil.

Residues decrease runoff and increase intake rates of water on most soils in the Great Plains. Residues maintained as a protective mulch on the surface bring about changes not only in the soil but also in plant growth. These changes sometimes result in depressed yields. These principles are being investigated in order to develop sound stubble mulch practices that will sustain crop production and still control erosion.

SOIL-CROP-CLIMATE STUDIES LEAD TO BETTER CROP PRODUCTION

BN-15315

The soil, climatic, and crop complex needs to be studied as a whole to determine how crops can use water more efficiently.

In the photograph above, the instruments are collecting climatic data above grain sorghum. From such data, procedures may be developed to estimate the rate of water use by the crop. Irrigations may then be scheduled on the basis of a knowledge of climatic factors alone. If this research is successful, the time-consuming and costly procedures now used, which involve periodic measurement of changes in soil moisture storage as the crops use water, could be eliminated.

SOIL COMPACTION LIMITS WATER INTAKE AND ROOT PENETRATION

BN-15316

Soil compaction is a problem in many soils and is aggravated by the increased use of heavy farming equipment. Compaction restricts root penetration, reduces water infiltration, and cuts crop yields.

Plant roots failed to penetrate the compacted layer present in the soil shown above. A distinct cleavage plane has developed, due to lack of root penetration into the compacted zone.

Research is underway to determine the causes of compacted layers, ways and means to prevent their formation, and corrective measures or practices to overcome such conditions.

CROP ROTATIONS INSURE DEPENDABLE YIELDS AND SOIL PROTECTION

BN-15317

Field plot studies similar to those shown above are necessary to determine the effects of specific crops and crop sequences on soil properties--water intake, soil tilth, organic matter, erodibility, and nutrient supplies.

The experimental plots above show a 2-year rotation system of cotton and oats-sweetclover. A 3-year rotation of cotton, sorghum, and oats-sweetclover is also being used. In the drier areas of the Great Plains where moisture is a limiting factor in crop growth, a wheat-sorghum-fallow sequence provides more dependable crop yields and conserves the land and water resources.

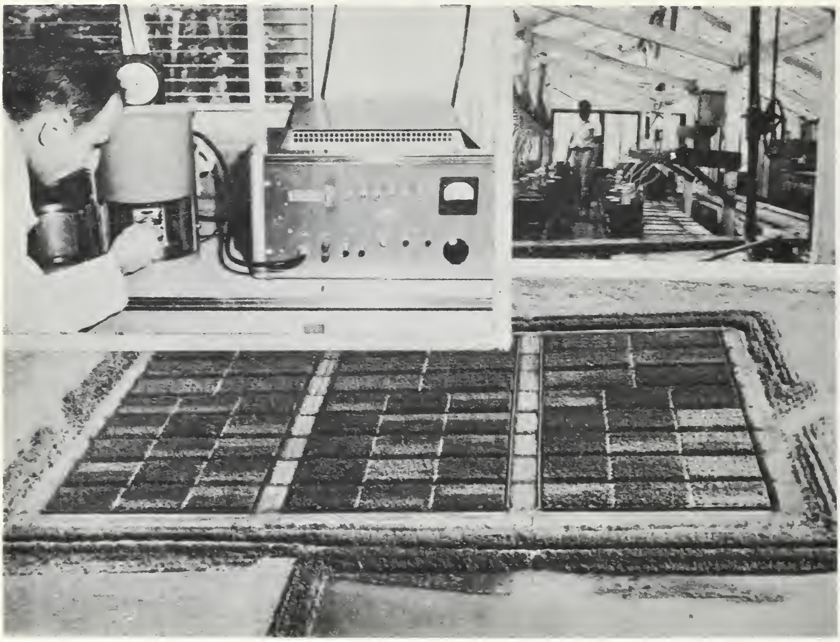
APPLICATION OF FERTILIZERS BENEFITS SOIL AS WELL AS THE CROP

BN-15318

Plant food needs for different cropping sequences in the Great Plans receive continuous and detailed study. Use of fertilizer for crops planted for soil conditioning is essential for maximum effectiveness in soil improvement and conservation.

Much has yet to be learned regarding the use of fertilizers in the many soil, climatic, and crop zones of the Great Plains, particularly under dryland conditions. Grain sorghum grown on sandy soils, as shown in this photograph, illustrates the need for nitrogen and phosphorus fertilizer. The nonfertilized plot on the left produced 57 bushels of grain per acre; the nitrogen-and-phosphorus-fertilized plot on the right produced 88 bushels. Although both plots were planted at the same time, the sorghum on the right matured earlier.

CONSERVATION PRACTICES THE RESULT OF RESEARCH IN LABORATORY, GREENHOUSE, AND FIELD PLOTS



BN-15319

Research provides factual information for which are developed conservation practices and measures that can be applied to the land. A scientist (upper left) uses laboratory equipment, and research in greenhouse (upper right) often solves problems by providing a large number of treatments that can be tested under controlled conditions. From these investigations, practices and treatments are compared and evaluated in an experimental field plot (as shown in lower part).

In this study, it is shown that exposed subsoils can be made productive through proper fertilizer practices, as indicated by the darker foliage of the grain sorghum.

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